Collaborative Human Engineering Work in Space Exploration Extravehicular Activities (EVA)

Lena DeSantis
Lockheed Martin Mission Services

Mihriban Whitmore, PhD
NASA Johnson Space Center

May 15, 2007
DoD HFE TAG #57

Concept of Operations for Future EVA activities

- Desert Research and Technology Studies (RATS)
- Advanced EVA Walkback Test
- Primary Life Support Subsystem (PLSS) design evaluations
- EVA Information System design evaluations

Desert RATS

- Collaboration with...
  - Other NASA Centers
  - Industry
  - Universities
- Technologies evaluated
  - Head mounted display
  - Speech recognition system
  - Rover usability
  - Backhoe usability

RATS 2005

Photo credit: NASA

Photo credit: NASA

Photo credit: NASA

Photo credit: NASA

RATS 2006

Photo credit: NASA

Photo credit: NASA

Photo credit: NASA

Photo credit: NASA

Photo credit: NASA

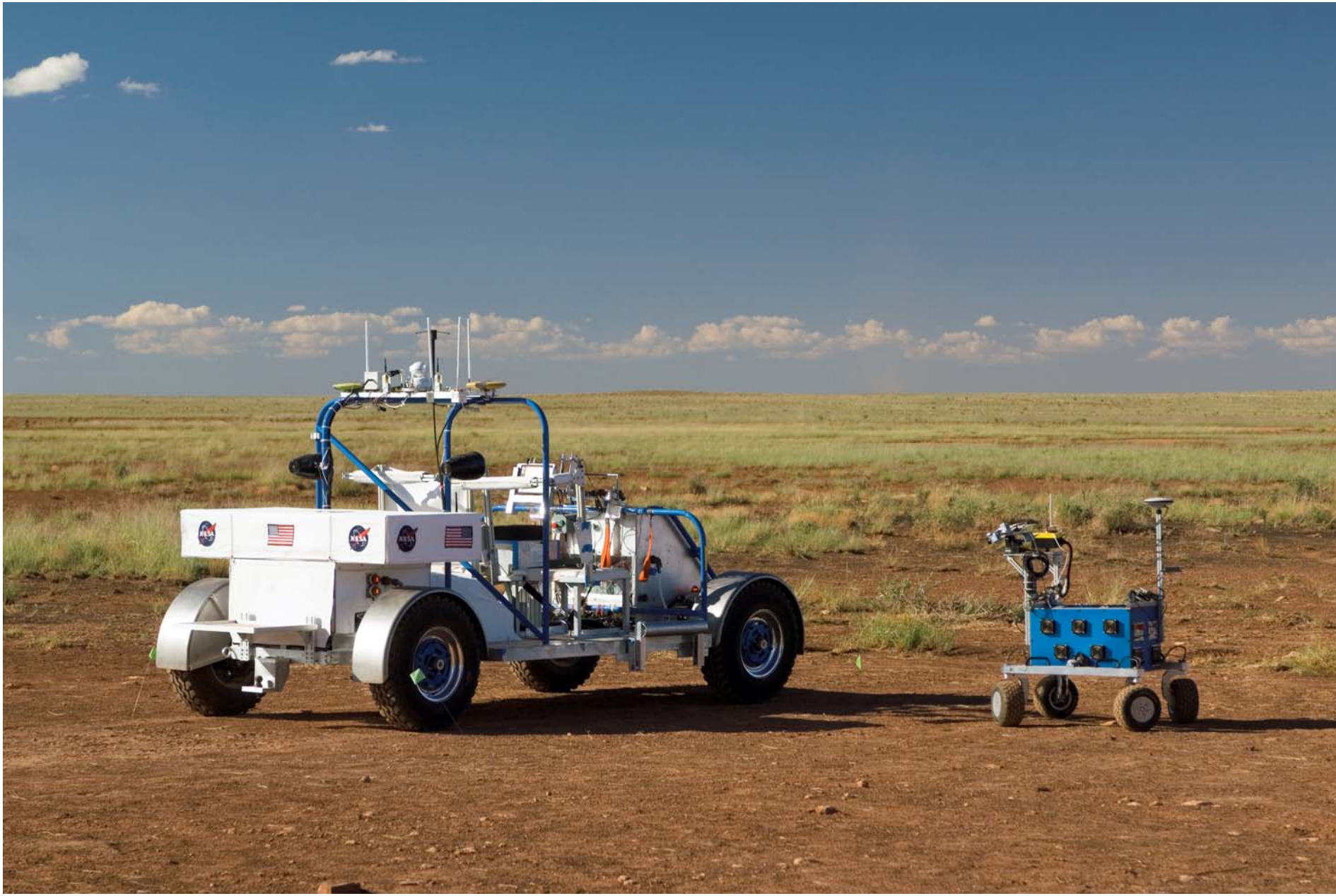


Photo credit: NASA

Photo credit: NASA

Advanced EVA Walkback Test

- Can a suited crewmember walk back 10 km at Lunar gravity?
- Collaboration with...
  - Multi-disciplinary team from within JSC
    - Exercise Physiology
    - Space Human Factors Labs
    - Engineering
    - Building 9 facility
- Metabolic costs
- Joint biomechanics
- Subjective measurements
  - Rating of perceived exertion (RPE)
  - Modified Cooper-Harper
    - CG stability
  - Discomfort
  - NASA TLX
  - Target tracking task

Walkback Subjective Results

- RPE = 11.8
- Cooper-Harper = 3.5
- Discomfort = 1.5
- NASA TLX
  - Physical demand and Effort – two factors contributing to workload
  - 40%, moderate amount of perceived workload
- Target tracking task
  - Participants gamed the system – were aware it was being used to assess cognitive capability
  - Two participants did not game the system
    - Performance was same pre and post for one
    - Increase in time to completion for the other

Integrated Suit Test 1

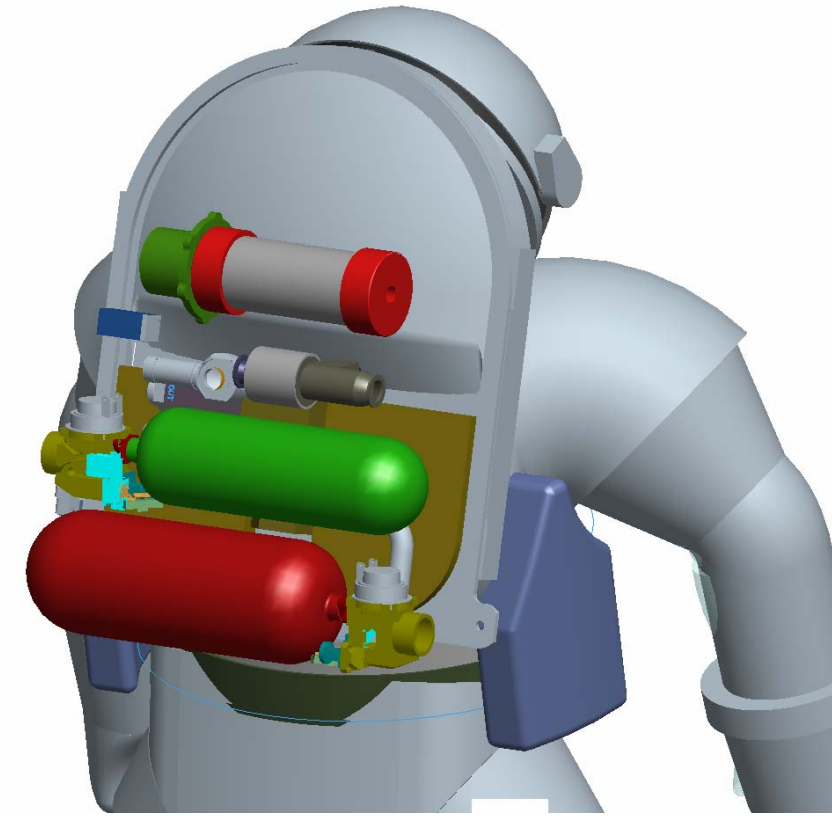
- Characterize suit parameters that contribute to metabolic costs of operating in a suit
  - Vary suit pressure
  - Vary suit weight
  - Vary inertial mass
- Currently collecting data – projected completion at the end of May 2007
- Subjective measurements
  - Rating of perceived exertion
  - Modified Cooper-Harper
  - Discomfort
  - Thermal comfort

Portable Life Support Subsystem (PLSS)

- Collaboration with...
  - Other NASA Centers
  - Industry
- Design evaluations for packaging PLSS components
- Human Factors personnel offering input on physical and visual access for maintenance and general good human factors practices

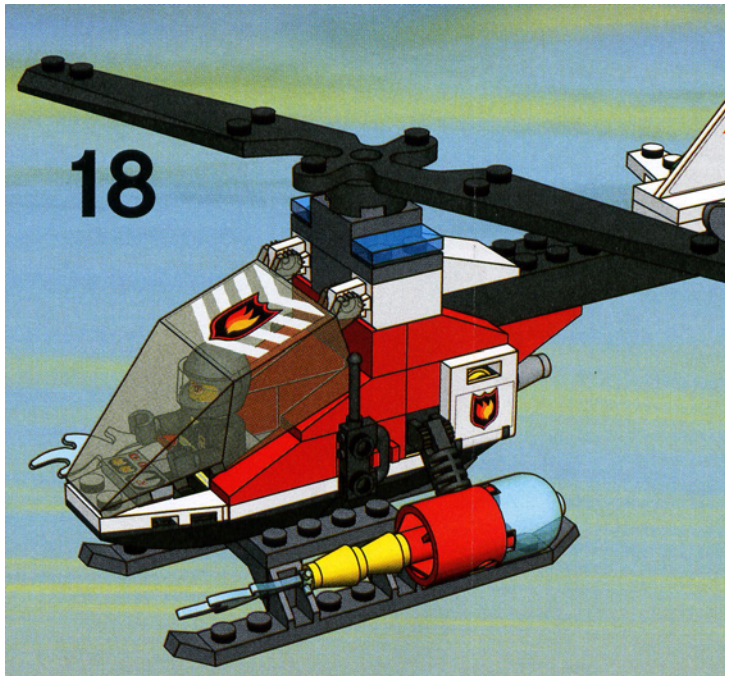
Flex PLSS Design Process

- Basic problem – time and money
- Goal – develop process to minimize schedules for design, efficient in redesign for any changes in future (new technology), utilize most effective tools we can find – reduce verification testing time
- Flex PLSS Packaging method allows for reconfiguration of the design – schematics, new technology, etc
- *Design Structure Matrix* (DSM) - standard representation for system architecture that can be used to address modularity and changeability associated with these criteria



EVA Information System

- Collaboration with Glenn Research Center (GRC)
- Proof of concept for a head mounted display and speech recognition system
- Initial human factors evaluation conducted at GRC in April 2007
  - Data is still being analyzed



C-2007-551

National Aeronautics and Space Administration
John H. Glenn Research Center at Lewis Field

C-2007-554

National Aeronautics and Space Administration
John H. Glenn Research Center at Lewis Field

C-2007-556

National Aeronautics and Space Administration
John H. Glenn Research Center at Lewis Field

EVA Information System

- Initial results – time to complete (min:sec ± min)
  - HMD 1st = 22:24 ± 5
  - HMD 2nd = 17:53 ± 5
  - Cue Cards 1st = 17:18 ± 4
  - Cue Cards 2nd = 11:21 ± 5
  - Geology = 6:26 ± 1

EVA Information System

- Initial recommendations for improvement
  - Improve the system's ability to recover from errors
  - Improve ease of adjustment on HMD, angular adjustment
  - Improve comfort of HMD – pinched head
  - Decrease wait period between keyword and command
  - Add an indicator to the display that voice commanding is activated
  - Add a zoom feature
  - Filter out background noise to reduce false-positives
  - Add a "mute" option

Thank you!

- Any Questions?